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force F is indicated by a following formula.

$$F = 2 \cdot m \cdot r \cdot \omega^2 \cdot \sin\omega t$$

where

m is a mass of an eccentric weight

r is a distance between the center of the vibratory shaft and the center of gravity of the eccentric weight

ω is an angular velocity of vibratory shaft.

Here, $m \cdot r$ is defined as eccentric moment (hereinafter $m \cdot r$ is indicated as "mr").

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Paragraph [0~~17~~ 16]

FIG.5 is an explanatory view showing the vibration of a vibratory roll equipped with a pair of vibratory shafts in case of horizontal vibration.

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Paragraph [0~~18~~ 17]

A vibration proof rubber provided between the vibratory roll and a frame (not shown) of the vibratory roller can be indicated as a model of a spring, which has a predetermined spring constant K_1 and which acts in a horizontal direction with respect to a shaft center O' of the vibratory roll.

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Paragraph [0~~19~~ 18]

A ground can be indicated as a model of a spring, which has a predetermined spring constant K_2 and which acts in a horizontal direction with respect to the contact surface between the vibratory roll and a ground.

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Paragraph [0~~21~~ 20]

Here, respective spring constant K_1 and K_2 are regarded as a negligibly small values by assuming respective springs are quite loose.

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Paragraph [0~~30~~ 29]

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In US Patent No.4,647,247, as described above, a total of two vibratory shafts, each of which is provided with an eccentric weight, are stored within the vibratory ~~shaft~~ roll, and the eccentric weight of one of the vibratory shafts is rotatably attached to the vibratory shaft. Therefore, the angular position between eccentric weights varies depending on the rotation direction of the vibratory shaft, but the eccentric moment in case of standard vibration is the same as the eccentric moment in case of horizontal vibration. Therefore, it has been difficult to control the amplitude of the eccentric moment to respective suitable amplitudes for the standard vibration and the horizontal vibration.

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Paragraph [0~~32~~]

The present invention relates to a vibratory mechanism. This vibratory mechanism includes vibratory shafts, which are stored within a roll and are arranged symmetrically across a rotation axis of the roll, a fixed eccentric weight fixed to respective vibratory shafts, a rotatable eccentric weight rotatably attached to respective vibratory shafts, a rotation controller controlling a range of movement of the rotatable eccentric weight, and an eccentric moment controller which changes an eccentric moment around the vibratory shafts depending on a rotation direction of the vibratory shafts.

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Paragraph [0~~33~~]

In this vibratory mechanism, the roll vibrates in all radial directions when respective vibratory shafts rotate in one direction, and the roll vibrates in a direction tangential to the circumference of the roll when respective vibratory shafts rotate in a reverse direction.

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Paragraph [0~~34~~]

In the vibratory mechanism, a total of two vibratory shafts, that is, a first vibratory shaft and a second vibratory shaft are stored in the roll, and the first vibratory shafts is arranged at a 180° opposite position across a rotation axis of the roll with respect to the second the vibratory shaft.

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Paragraph [0~~35~~34]

In this vibratory mechanism, a total eccentric moment around the first vibratory shaft is substantially the same as a total eccentric moment around the second vibratory shaft, when the first vibratory shaft and the second vibratory shaft are rotated in one direction. Additionally, a total eccentric moment around the first vibratory shaft is substantially the same as a total eccentric moment around the second vibratory shaft, when the first vibratory shaft and the second vibratory shaft are rotated in the reverse direction.

KM 2/22/07

Paragraph [0~~36~~35]

Here, the total eccentric moment around the first vibratory shaft is obtained by subtracting an eccentric moment of the fixed eccentric weight from an eccentric moment of the rotatable eccentric weight and the total eccentric moment around the second vibratory shaft is obtained by subtracting an eccentric moment of the rotatable eccentric weight from an eccentric moment of the fixed eccentric weight, when the first vibratory shaft and the second vibratory shaft are rotated in one direction. Additionally, the total eccentric moment around the first vibratory shaft is obtained by adding an eccentric moment of the fixed eccentric weight to an eccentric moment of the rotatable eccentric weight and the total eccentric moment around the second vibratory shaft is obtained by adding an eccentric moment of the rotatable eccentric weight to an eccentric moment of the fixed eccentric weight, when the first vibratory shaft and the second vibratory shaft are rotated in the reverse direction.

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Paeragraph [0~~40~~39]

FIG.2A is a sectional view along the line E-E in FIG.1, wherein the vibratory roll is causing standard vibration.

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Paragraph [0~~41~~40]

FIG.2B is a sectional view along a line E-E in FIG.1, wherein the vibratory roll is causing horizontal vibration.

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Paragraph [04~~2~~ 41]

FIGS.3A – 3D are ~~is a~~ side sectional views explaining a vibratory force caused under horizontal vibration.

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Paragraph [04~~5~~ 44]

DETAILED DESCRIPTION OF THE ~~PREFERRED~~ PRESENT EMBODIMENT

As shown in FIG.1, a vibratory roll 1 is rotatably supported by support boards 2, which are fixed to a frame of a vibratory roller (not shown), respectively.

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Paragraph [0~~50~~ 49]

The axle shaft 7 is connected to a power transmission unit 14a of a drive motor 14 through a mounting plate 13. A stationary part 14b of the drive motor 14 is fixed to the support board 2 through a mounting plate 15 and a vibration proof rubber 16. In this embodiment, a motor, such as an hydraulic motor, is used as the drive motor 14.

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Paragraph [05~~2~~ 51]

Each of bearings 21, such as roller bearings, located within the axle shaft 6 rotatably supports the gear shaft 20 so that the gear shaft 20 becomes parallel and coaxial with respect to the shaft center of the vibratory roll 1. The gear shaft 20 is provided with a drive gear 23, such as a spur gear, at an end part thereof so that the drive gear 23 is positioned within the housing case 5.

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Paragraph [05~~3~~ 52]

In this embodiment, a motor, such as an hydraulic motor, is used as the reversible motor 18, and the rotation axis thereof is allowed to rotate in both clockwise and anticlockwise directions.

KM 2/22/07

Paragraph [0~~60~~ 59]

As shown in FIGS.2A, 2B, the fixed eccentric weight 32 is composed of an arch part 32a

and an eccentric part 32b. The arch part 32a surrounds part of the circumference of the vibratory shaft 24 and fixed thereon. The eccentric part 32b having an approximately half-round shape surrounds the remainder of the circumference of the vibratory shaft 24 and is eccentrically fixed thereon.

KM 2/22/07

Paragraph [0~~67~~66]

As shown in FIGS.2A, 2B, the fixed eccentric weight 33 is composed of an arch part 33a and an eccentric part 33b. The arch part 33a surrounds part of the circumference of the vibratory shaft 25 and is fixed thereon. The eccentric part 33b having an approximately half-round shape surrounds the remainder of the circumference of the vibratory shaft 25 and is eccentrically fixed thereon.

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Paragraph [0~~68~~67]

A stopper 37 constituting the rotation controller 30 is a pole-shaped object. This stopper 37 (shown by dot-dash line in FIG.1) is inserted into a through-hole provided on respective fixed eccentric weights 33. Thereby, as shown in FIG.1, the stopper 37 (shown by dot-dash line) is provided across fixed eccentric weights ~~32~~ 33 and ~~32~~ 33 so that the stopper 36 becomes parallel with respect to the vibratory shaft 25.

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Paragraph [0~~69~~68]

The rotatable eccentric weight 35 is composed of an arch part 35a and an eccentric part 35b. The arch part 35a surrounds part of the circumference of the vibratory shaft 25. The eccentric part 35b having a half-round shape surrounds the remainder of the circumference of the vibratory shaft 25 and is eccentrically attached to the vibratory shaft 25. In this embodiment, the rotatable eccentric weight ~~34~~ 35 is mounted rotatably about the vibratory shaft 25.

KM 2/22/07

Paragraph [0~~73~~72]

In this embodiment, respective fixed eccentric weights 32 and 33 are fixed to respective vibratory shafts 24 and 25 so that the eccentric part 33b of the fixed eccentric weight 33 is

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positioned in the right side with respect to a center line 38 connecting the shaft centers of respective vibratory shafts 24 and 25, if the eccentric part 32b of the fixed eccentric weight 32 is positioned in the left side with respect to the center line 38.

KM 2/22/07 Paragraph [0~~76~~78]

Here, m_1, m_2, m_3, and m_4 are mass of respective eccentric weights, r_1 and r_2 are the distance from the center of the vibratory shaft 24 to the center of ~~the~~ gravity of respective eccentric weights 32 and 34, and r_3 and r_4 are the distance from the center of the vibratory shaft 25 to the center of ~~the~~ gravity of respective eccentric weights 33 and 35.

KM 2/22/07 Paragraph [0~~80~~79]

In this case, the center of the gravity of the fixed eccentric weights 32 (33) is in the opposite side across the vibratory shaft 24 (25) with respect to the center of ~~the~~ gravity of the rotatable eccentric weights 34 (35).

KM 2/22/07 Paragraph [0~~82~~81]

In this case, as shown in FIG.2B, the fixed eccentric weights 32 (33) and the rotatable eccentric weight 34 (35) are rotated in the same angular position, when the vibratory shaft 24 (25) rotates anti-clockwise. That is, the phase difference between the fixed eccentric weights 32 (33) and the rotatable eccentric weight 34 (35) is zero.

KM 2/22/07 Paragraph [0~~83~~82]

In the present embodiment, as for the vibratory shaft 24, the eccentric moment (m_2r_2) of the rotatable eccentric weight 34 is larger than the eccentric moment (m_1r_1) of the fixed eccentric weights 32, $m_2r_2 > m_1r_1$. As for the vibratory shaft 25, the eccentric moment (m_4r_4) of the movable eccentric weight 35 is smaller than the eccentric moment (m_3r_3) of the fixed eccentric weights 33, $m_3r_3 > m_4r_4$.

KM 2/22/07 Paragraph [0~~94~~93]

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Thereby, the vibratory roll 1 receives the vibratory force, which is the sum of vibratory forces that are caused from respective vibratory shafts 24 and 25 and that have the same value, and is vibrated in 360° directions (in all radial directions).

KM 2/22/07

Paragraph [~~097~~] 96

FIG.3A through FIG.3D illustrates eccentric weights in four different angular positions. The angular position shown in FIG.2B is the same as that shown in FIG.3D.

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Paragraph [~~099~~] 98

In the case of FIG.3A, the force directed to the center of the vibratory roll 1 is caused on the vibratory shaft 24, and the force directed to the center of the vibratory roll 1 is also caused on the vibratory shaft 25, which is positioned in the opposite position across the shaft center O with respect to the vibratory shaft 24. Therefore, as can be seen from FIG.3A, since these forces have the same value, these forces are canceled by each other.

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Paragraph [~~102~~] 101

In the case of FIG.3C, the force directed away from the center of the vibratory roll 1 is applied to the vibratory shaft 24, and the force directed away from the center of the vibratory roll 1 is applied to the vibratory shaft 25. Thereby, these forces are canceled by each other.

KM 2/22/07

Paragraph [~~111~~] 110

As for FIG.1, if it is assumed that the vibratory roll has a dimension of 1 meter and has about 15 millimeters (hereinafter indicated as "mm") thickness, the drum weights M_0 is about 720 kg and the eccentric moment around center axis O of the vibratory roll 1 is about 155 kgm^2.

KM 2/22/07

Paragraph [~~123~~] 122

According to this vibratory mechanism having these constructions, the roll vibrates in all radial directions when respective vibratory shafts rotate in one direction, and the roll vibrates in a direction tangential to the circumference of the roll when respective vibratory shafts rotate in the

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reverse direction. Thereby, the amplitude of the vibratory roller can be controlled for the use in standard vibration or horizontal vibration.

KM 2/22/07 Paragraph [~~125~~] 124

In this occasion, a total eccentric moment around the first vibratory shaft 24 is substantially the same as a total eccentric moment around the second vibratory shaft 25, when the first vibratory shaft 24 and the second vibratory shaft 25 are rotated in one direction (for example, anti-clockwise), and a total eccentric moment around the first vibratory shaft 24 is substantially the same as a total eccentric moment around the second vibratory shaft 25, when the first vibratory shaft 24 and the second vibratory shaft 25 are rotated in the reverse direction (for example, clockwise).

KM 2/22/07 Paragraph [~~126~~] 125

Here, the total eccentric moment around the first vibratory shaft 24 is obtained by subtracting an eccentric moment (m_1r_1) of fixed eccentric weights 32 from an eccentric moment (m_2r_2) of rotatable eccentric weight 34 and the total eccentric moment around the second vibratory shaft 25 is obtained by subtracting an eccentric moment (m_4r_4) of rotatable eccentric weight 35 from an eccentric moment (m_3r_3) of fixed eccentric weights 33, when the first vibratory shaft 24 and the second vibratory shaft 25 are rotated in one direction (for example, anti-clockwise), and the total eccentric moment around the first vibratory shaft 24 is obtained by adding an eccentric moment of fixed eccentric weights 32 to an eccentric moment of rotatable eccentric weight 34 and the total eccentric moment around the second vibratory shaft 25 is obtained by adding an eccentric moment of rotatable eccentric weight 35 to an eccentric moment of fixed eccentric weights 33, when the first vibratory shaft 24 and the second vibratory shaft 25 are rotated in the reverse direction (for example, clockwise).

KM 2/22/07 Paragraph [~~128~~] 127

As an example of the movable eccentric weight, the mechanism disclosed in Japanese Unexamined Patent publication No.S61-40905 (equivalent to US Patent No.4,586,847) can be

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cited. In this patent publication, the vibratory roll, in which inner walls and liquidity weights are provided, is disclosed. In this vibratory roll, liquidity weights, which ~~is~~ are stored in the vibratory roll and which move along the inside-circumference of the roll when the vibratory roll is rotated, correspond to the rotatable eccentric weight. Inner walls which restrict the range of the movement of the liquidity weights correspond to the rotation controller.

KM 2/22/07

Paragraph [~~130~~] 129

Here, the eccentric moment m_1r_1 around the first vibratory shaft 24 of the fixed eccentric weights 32 is substantially the same as the eccentric moment m_4r_4 around the second vibratory shaft 25 of the rotatable weight 35, and the eccentric moment m_2r_2 around the first vibratory shaft 24 of the rotatable eccentric weight 34 is substantially the same as the eccentric moment m_3r_3 around the second vibratory shaft 25 of the fixed eccentric weights 33.

KM 2/22/07

Paragraph [~~134~~] 133

In the above described embodiment, a total of two vibratory shafts are provided within the vibratory roll. But the numbers of the vibratory shaft is not restricted to this. For example, the vibratory roll which includes a total of four vibratory shafts may be adoptable. In this vibratory roll, vibratory rolls having the same construction are provided around the rotation shaft of the vibratory roll at a phase difference of 90°.

KM 2/22/07

Paragraph [~~135~~] 134

In the present invention, additionally, each of the fixed eccentric weights is provided separately from the vibratory roll. But ~~this~~ these fixed eccentric weights may be provided as a single unit with the corresponding vibratory shafts.

KM 2/22/07

Paragraph [~~037~~] 136

Although there have been disclosed what ~~are~~ is the ~~patent~~ present embodiment of the invention, it will be understood by persons skilled in the art that variations and modifications may be made thereto without departing from the scope of the invention, which is indicated by the